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KOOTENAI RIVER FISHERIES INVESTIGATIONS:

CHAPTER 3

MAINSTEM HABITAT USE AND RECRUITMENT ESTIMATES OF RAINBOW TROUT

Period Covered: January 1, 1996 - December 3 1, 1996

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ABSTRACT

The objective of this study was to determine if recruitment is limiting the population of rainbow trout ***Oncorhynchus mykiss*** in the mainstem Kootenai River. We used snorkeling and electrofishing techniques to estimate juvenile rainbow trout density and total numbers in Idaho tributaries, and we trapped juvenile outmigrants to identify the age at which juvenile trout migrate from tributaries to the Kootenai River. We radio and reward-tagged post-spawn adult rainbow trout captured in Deep Creek to identify river reach and habitat used by those fish spawning and rearing in the Deep Creek drainage. We also conducted redd surveys in the Kootenai River to determine the extent of mainstem spawning. Based on the amount of available habitat and juvenile rainbow trout densities, the Deep Creek drainage was the most important area for juvenile production. Population estimates of age 0, age 1+, and age 2+ rainbow trout indicated moderate to high densities in several streams in the Deep Creek drainage (40 - 110 fish/100 m^2), whereas other streams, such as Deep Creek, had very low densities of juvenile trout (7.8 fish/l 00 m^2). The total number of age 0, age 1+, and age 2+ rainbow trout in Deep Creek drainage in 1996 was estimated to be 63,743, 12,095, and 3,095, respectively. Radio telemetry efforts were hindered by the limited range of the transmitters, but movements of a radio-tagged trout and a returned reward tag indicated that at least a portion of the trout utilizing the Deep Creek drainage migrated downriver from the mouth of Deep Creek to the meandering section of river. We found no evidence of mainstem spawning by rainbow trout, but redd counting efforts were hindered by high flows from mid-April through June.

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INTRODUCTION

The Kootenai River has undergone the recent loss or decline of several once relatively productive fisheries (sturgeon ***Acipenser transmontanus,*** burbot *Lota lota*, bull trout ***Salvelinus confluentus,*** kokanee ***Oncorhynchus nerka,*** and whitefish ***Prosopium williamsoni***). Currently, rainbow trout ***0. mykiss*** provide the most important fishery in the river. However, densities of rainbow trout are low, and it is not widely regarded as a good fishery. Partridge (1983) estimated catch rates of 0.06 trout/h in 1982-83, and Paragamian (1995) reported catch rates of 0.03 trout/h over a similar period of time in 1993-94. In contrast, catch rates of at least 1 .O fish/h are typical of "quality" trout fisheries in other rivers throughout Idaho (Idaho Department of Fish and Game [IDFG] 1996).

Paragamian (1994) reported that, although poor, the rainbow fishery has remained relatively stable since the work of Partridge (1983). Partridge (1983) and Paragamian (1994) both suggested recruitment is primarily from the tributaries. Both authors reported high densities of juvenile trout in Deep Creek tributaries, but noted the limited amount of suitable and/or accessible habitat. Partridge (1983) reported that most of the juvenile production in the Idaho reach of the Kootenai River was probably from Fall Creek, Trail Creek, and Ruby Creek and hypothesized that quantity and quality of spawning and rearing habitat was limiting the rainbow trout population. This hypothesis is largely dependent on the absence or near absence of successful spawning in the mainstem. No information is currently available regarding rainbow trout spawning in the Idaho reach of the Kootenai River; however, researchers with Montana Department of Fish, Wildlife, and Parks (MDFWP) report counting 20-40 redds each year in the approximately 2.5 km reach above the town of Libby, MT (Steve Dalbey, Fisheries Biologist, MDFWP, personal communication). These are reported to be large fish, capable of spawning in relatively large gravel and small cobble (up to 12 cm diameter) (Skaar 1993).

We have little information on the river habitat used by juvenile rainbow trout in the mainstem river. There are approximately 105 km of Kootenai River in Idaho with the following three distinct reaches based on habitat types (Figure 1): 1) the canyon reach (22 km) from the Montana border to the Moyie River, 2) the braided reach (10 km) from the Moyie River to Bonners Ferry, and 3) the meandering reach (73 km) from Bonners Ferry to the Canadian border. Based on substrate, velocity, and depth, the reaches above Bonners Ferry appear to be the most suitable rainbow trout habitat, yet the sources of recruitment to this area are unknown. Juveniles produced in the Deep Creek drainage would have to travel upriver after emigrating from Deep Creek to utilize this habitat. Similar (though not identical) migrations have been documented in other salmonid stocks. Cutthroat trout 0. *clarki* in Yellowstone Lake spawn, in part, in the outlet area of the Yellowstone River. Progeny from this stock have been shown to migrate upstream to the rearing area, and are evidence of genetically controlled migration patterns (Bowler 1975, Raleigh and Chapman 1971). Other studies have demonstrated upstream migrations from natal streams to rearing areas in salmonids (Raleigh 1971, Brannon 1967).

Ultimately, the question of whether or not the system is recruitment limited can be answered only after we have obtained a numerical estimate of juveniles entering the river, an estimate of in-river survival, and an estimate of the number of juveniles required to fully seed the Kootenai River. Also of importance is an understanding of the river habitat utilized by adult

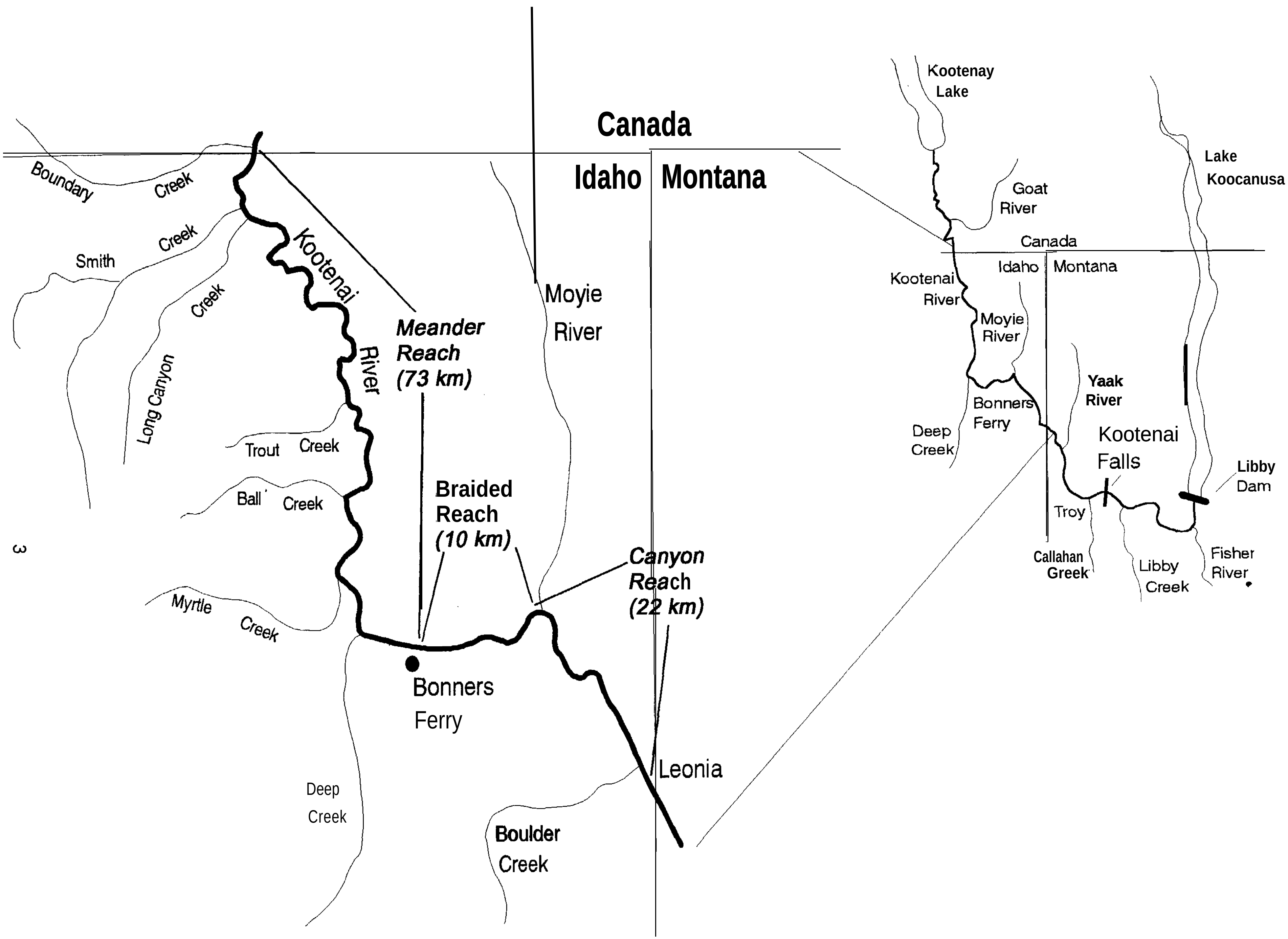

Figure 1. Map of the Kootenai River and significant tributaries from Libby Dam, Montana to Kootenay Lake, British Columbia. Expanded portion depicts the three broad habitat types within the Idaho reach of the Kootenai River.

rainbow trout (i.e., which fishery are juvenile rainbow trout contributing to?). If the fishery is found to be recruitment limited, it might be enhanced by improving and/or expanding existing spawning and rearing habitat in tributaries, reestablishing a more suitable rearing environment for juvenile rainbow trout, or supplementing natural recruitment by stocking rainbow trout fingerlings.

Research goal: Improve the rainbow trout fishery in the Kootenai River.

Objective: Determine if the rainbow trout population in the Idaho reach of the Kootenai River is limited by juvenile production and survival.

METHODS

Tributary Production

Stream Population Estimates

We conducted an extensive population estimate of juvenile rainbow trout in the Kootenai River tributaries. Tributaries surveyed included Trail Creek, Ruby Creek, Fall Creek, Dodge Creek, Browns Creek, Deep Creek, Snow Creek, Caribou Creek, Boulder Creek, and Myrtle Creek. With the exceptions of Myrtle Creek and Boulder Creek, all of the streams surveyed are Deep Creek tributaries (Figures 1 and 2). We focused on the Deep Creek drainage because previous studies indicated these streams comprised the majority of spawning and rearing habitat in the Idaho reach of the Kootenai River (Partridge 1983, Paragamian 1994). We followed a similar methodology to that outlined by Hankin and Reeves (1988). The methodology entails a two stage design with the following components: 1) estimation of total habitat in the system, and 2) estimation of fish densities in subsamples of the habitat.

In the Deep Creek drainage, we first surveyed the portion of each stream accessible to fluvial rainbow trout and categorized habitat as one of four basic types--pools, riffles, glides, and pocket water (all streams contained pools, riffles, and glides, but several did not have any habitat classed as pocket water). We measured the length of each habitat unit with a rangefinder, and estimated the width by taking three to five width measurements per habitat unit with a stadia rod and calculating the mean. We then systematically selected units of each habitat type to be snorkeled and estimated densities of age 0, age 1+, and age 2+ (and older) rainbow trout and brook trout *S. fontinalis* using visual counts. Mean density of rainbow trout for each habitat type was estimated using .a standard ratio estimator (Scheaffer et al. 1990: 154):

$$r = \frac{\sum_{i=1} y_i}{\sum^{n} x_i} \qquad (1)$$

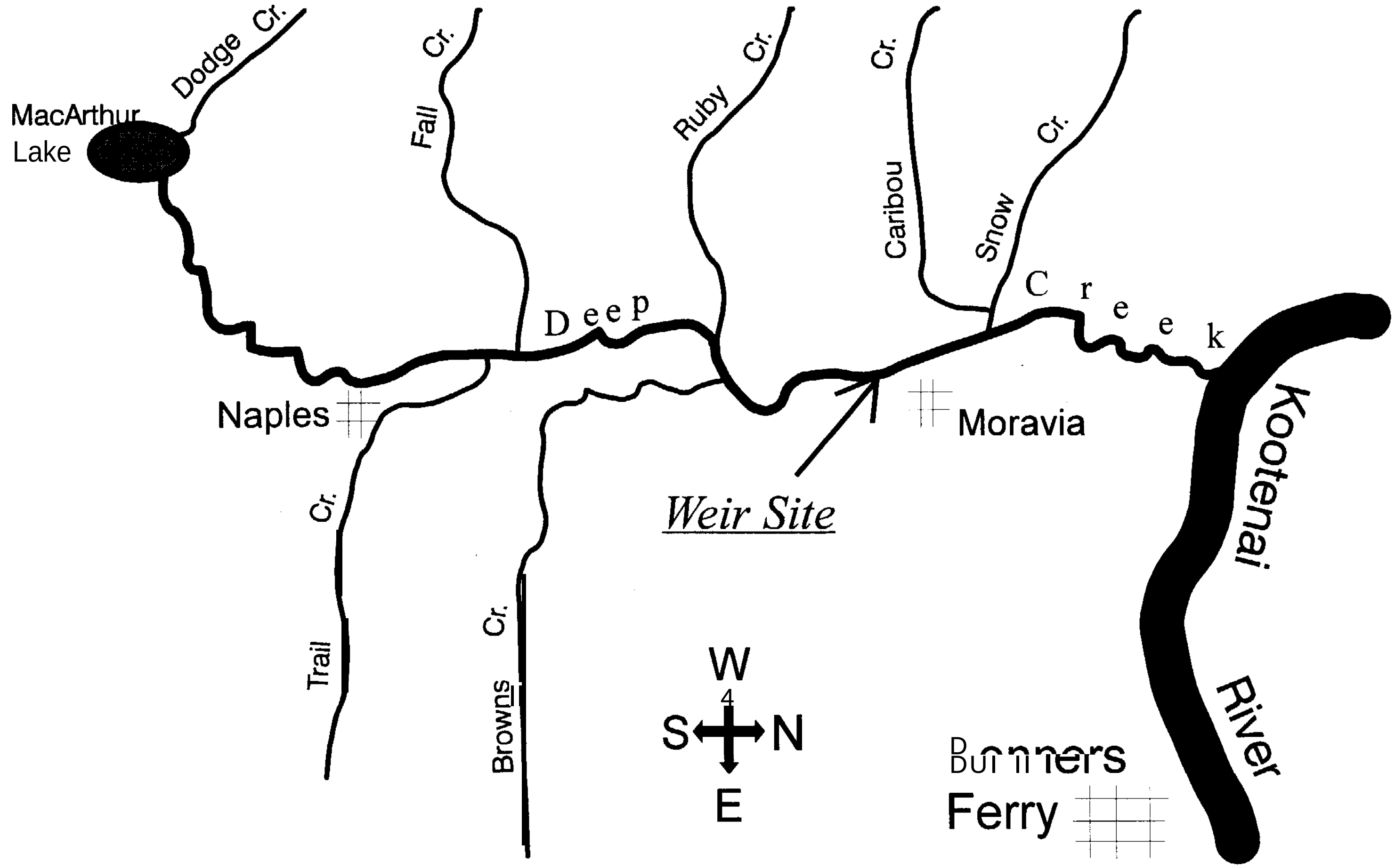

Figure 2. Location of the fish weir in Deep Creek.

where:

n	= number of habitat units snorkeled
Y	= trout estimates (no. counted)
X	= habitat area (m^2)

Variance of the ratio was then estimated as (Scheaffer et al. 1990:155):

$$V(r) = \left(N - \frac{n}{Nn}\right)\left(\frac{1}{\mu x^2}\right)\frac{\sum_{i=1}^{n}(yi - rxi)^2}{(n-1)} \qquad (2)$$

Where:

N	= total number of habitat units
ux	= mean habitat size (m^2)
r	= mean density

Assignment into age classes was done based on total length (TL) estimation (age 0 = TL <75 mm; age 1 = TL 75-125 mm; age 2+ = TL >125 mm) and confirmed by scale analysis. We attempted to snorkel at least ten units of each habitat type for a given stream. The estimated density of each age class (e.g., age 0/100 m^2) was extrapolated to the total area of each habitat type in a given stream. This provided an estimate of the total number of fish in pools, riffles, glides, and pocket water, as well as the total for the stream. Variance of the total number of fish in each habitat type was estimated as (Scheaffer et al. 1990: 159):

$$V(T_y) = T_x^2\left(N \frac{n}{Nn}\right)\left(\frac{1}{\mu x^2}\right)\frac{\sum_{i=1}^{n}(yi - rxi)^2}{(n-1)} \qquad (3)$$

Where:

T_x	= total habitat area,

and variances of the four habitat types were summed to estimate the variance of the total stream population.

Deep Creek, Trail Creek, and Ruby Creek were characterized by distinct reaches (high gradient, erosional channel type, and low gradient, depositional channel type). These streams were therefore separated by reach and treated as individual streams. We used a digital flow meter (Marsh McBirney, model 201D) to estimate discharge of each stream during the period that habitat surveys and fish population estimates were made to provide a reference point for future stream surveys.

Because snorkeling generally underestimates numbers, we used a backpack electrofisher and block-nets to make additional estimates of density. We used three to four pass depletion estimates in a subsample of the snorkeled habitat units. Correction factors were developed to apply to snorkel counts by assuming the depletion estimates were close to the true population for a given habitat. Electrofishing estimates were made in representative units of all four habitat types (pools, riffles, glides, pocket water). Two units of each habitat type were electrofished for most of the streams sampled (i.e., two pools, two riffles, etc. in each stream). We initially calculated correction factors by 1) age class, and 2) habitat type, but eventually pooled the four correction factors for each habitat type and used separate correction factors only for the different age classes.

Deep Creek Weir

We installed a weir in Deep Creek which was used in conjunction with upstream and downstream fish traps. The weir site was near Moravia, far enough downstream to collect fish moving to and from most tributary streams in the drainage (Figure 2). The weir was intended to 1) provide an estimate of total juvenile production in the Deep Creek drainage, 2) collect spawning adults for tagging, and 3) provide information on the size, age, and timing of juvenile rainbow trout outmigration. Based on subsequent stream surveys and past research (Partridge 1983, Paragamian 1994) the streams important for rainbow trout spawning and rearing above the weir were Ruby Creek, Browns (Twentymile) Creek, Fall Creek, Trail Creek, and Dodge Creek. Snow Creek and Caribou Creek are the only two streams in the Deep Creek drainage that entered downstream of the weir site. The weir was made of conduit pickets held in place by angle iron frames, which in turn were held in place by large tripods constructed of scaffolding material. The weir was angled to direct outmigrants to the downstream trap, while directing upstream migrating adults to the upstream trap (Figure 3). The downstream trap was an inclined plane style trap, primarily designed for catching juvenile trout. During the low flow period (July - October), we placed 6 mm plastic netting on the upstream side of the weir to reduce the potential for small trout to swim through the pickets.

The trap was checked twice daily (around 0700 and 1800) to assess any diel pattern of downstream migration. Juvenile fish were measured and, throughout the season, scales were taken from a subsample of 10 fish per each 10 mm length group for age determination. Fish were then adipose fin-clipped and transported about 200 m upstream for the purpose of estimating trap efficiency. Initially only a small number of trout were collected each day, and all juvenile fish captured were marked and released upstream. When the number of outmigrants trapped each day increased to 20-30, we released only a single batch of marked fish per week. Because of the rapidly fluctuating water level, we continually altered the trapping techniques by adding/removing plastic netting on the weir, removing the weir, moving the trap from mid-channel to near shore, and even removing the trap entirely. Trap efficiency **was** estimated based on the number of marked fish reentering the trap. We estimated separate capture efficiencies for each trap configuration to account for the variable trapping techniques. We estimated total daily outmigration by correcting the daily catch with the estimated efficiency for each trap configuration.

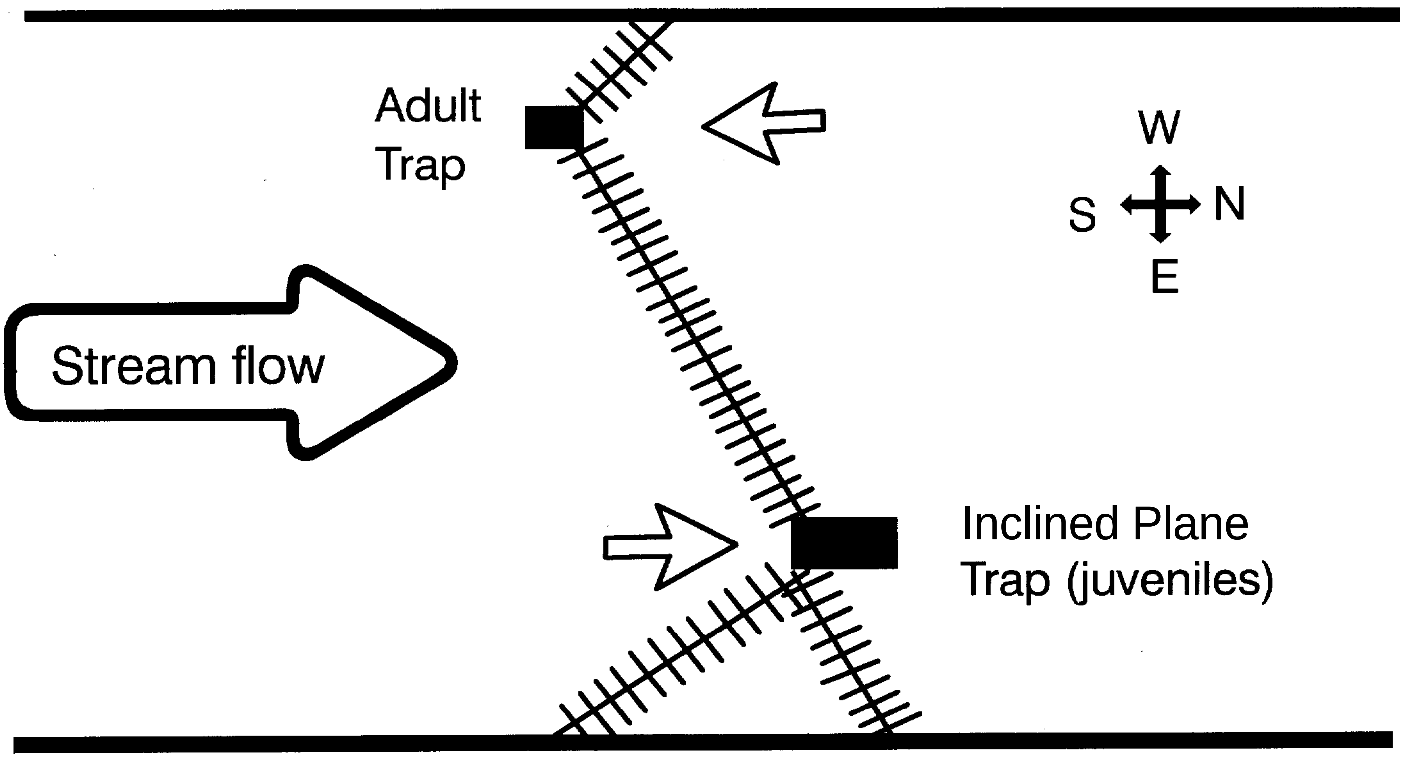

Figure 3. The basic configuration of the fish weir in Deep Creek, with the upstream (spawner) trap and downstream (outmigrant) inclined plane trap.

In addition to the number of fish collected each day, we recorded water temperature and gage height. We periodically measured discharge at a site near the weir and used a gage height/discharge regression to estimate daily discharge ($r^2 = 0.99$, $p<0.01$).

Mainstem Habitat Use

Redd Surveys

We conducted weekly redd surveys in the main Kootenai River from river kilometer (rkm) 248 (just above Bonners Ferry) to rkm 264 (near Hemlock Bar). The surveys were conducted along cross-sectional transects, about 30 m in width, at 3 km intervals. We attempted to identify redds by searching from a boat, but also experimented with a mask and snorkel (and dry suit). In addition to the transects at 3 km intervals, we searched other areas that appeared to be potential spawning sites.

Adult Trout Tagging

We used two methods of adult trout tagging to provide information on the movements of trout after leaving the spawning area. Ten dollar reward tags (Floy T-bar style) were attached to both pre-spawn and post-spawn rainbow trout collected at the weir, and with conventional fishing equipment above the weir.

In addition to the reward tags, we surgically implanted radio tags (30 MHZ frequency, 5 g, 75-150 day life expectancy) in eight rainbow trout collected in the Deep Creek drainage. Between May 23 and June 20 we radio-tagged eight adult rainbow trout, all of which had previously spawned. Of the eight trout implanted with radio-tags, three were collected in the downstream trap at the weir, and five were collected with conventional fishing equipment above the weir (four at the mouth of Trail Creek and one in Trail Creek about 5 km above the mouth). Implanted fish ranged in size from 36 to 52 cm TL and were all greater than 250 g, thereby keeping transmitter weight at less than 2% of body weight (Winter 1983). Tags were equipped with an external trailing whip antenna, that was passed through the abdominal wall just posterior to the pelvic girdle. Surgical implantation was similar to the procedure described by Ross and Kleiner (1982). Unfortunately, we found, the frequency of the transmitters limited the reception range to less than 0.5 km when trout were in depths greater than 3 m. To afford the greatest chance of locating tagged fish, we stopped the boat every 200-300 m to scan for the transmitters, and we covered only 20-30 km per day. During June, we attempted to locate the radio-tagged fish two to three times per week, searching from near Copeland to the Montana border. From July through September, our efforts were less intensive and were only incidental to the sturgeon and burbot telemetry. In early October, we conducted a thorough search, this time from the Montana border to the Canadian border.

RESULTS

Tributary Production

Stream Population Estimates

Accuracy of Snorkel Estimates-We used simple linear regression to plot snorkel counts against the “true” numbers in a sampled habitat (based on electrofishing depletion estimates). We initially estimated correction factors for each separate habitat, but because of low r^2 values, we lumped all habitat types to develop an overall correction factor for each age class. The correction factor (beta coefficient) for age 0 trout was 1.23 multiplied by the number counted (i.e., we counted 82% of actual number). The correction factor for age 1+ trout was 1 .1 6 multiplied by the number counted (i.e., we counted 86% of actual number). Snorkel counts were most accurate (based on correlation coefficients) when used to estimate numbers of age 0 rainbow trout, particularly in riffle habitats (appendix A). We were less consistent with snorkel counts in glides and pools. We found a very poor relationship between count estimates for age 2+ (and older rainbow trout) and the number estimated by electrofishing, and we did not use the slope of the regression line to correct the count estimates. For this reason count estimates of rainbow trout older than 1+ are most likely underestimates of their true abundance.

Population Estimation-We visually observed and electrofished multiple age classes of rainbow trout during the surveys of Deep Creek and its tributaries. Age 0 rainbow trout were the most abundant age class, with numerous age 1+, and few older fish. The total estimated numbers of age 0, age 1+, and age 2+ rainbow trout produced in the Deep Creek drainage in 1996 were 63,743, 12,909, and 3,095, respectively (Table 1). Of all streams surveyed in 1996, Trail Creek had the highest estimated density of juveniles and the greatest total number of age 0 and age 1+ rainbow trout (with the exception of Deep Creek), with 39% and 24% of the totals, respectively (Table 1). Estimated mean densities of juvenile rainbow trout (age 0 to age 2+) in the surveyed streams ranged from 4.5 fish/100 m^2 in Myrtle Creek to 108 fish/100 m^2 in Trail Creek (Table 2). Deep Creek had some of the lowest trout densities of all streams surveyed, yet by virtue of its size, produced the highest total number of age 1+ and the fourth highest number of age 0 rainbow trout. Pool and glide habitats usually had the highest densities of rainbow trout (Table 3). A notable exception was Deep Creek, where the highest densities were found in riffles (this was possibly related to water temperature and dissolved oxygen levels).

The three high gradient streams flowing from the Selkirk mountains (Caribou Creek, Snow Creek, Myrtle Creek) were the least important streams based on both densities and total estimated number of trout. All of these streams have passage barriers not far from their mouths (2-3 km) limiting the habitat available to fluvial rainbow trout. In addition, these streams have a higher gradient and relatively pristine, non-productive water in comparison to Trail Creek, Ruby Creek, and Fall Creek.

Table 1. Estimated total number of juvenile rainbow trout, by age class, in Kootenai River tributaries from July through September, 1996. All tributaries are within the Deep Creek drainage with the exception of Boulder Creek and Myrtle Creek.

Stream	Age 0+	Age 1+	Age 2+	Brook Trout
Trail Creek	24,727 (+/- 3,295)	3,119 (+/- 325)	840 (+/- 88)	37
Ruby Creek	10,603 (+/- 2,653)	1,980 (+/- 321)	358 (+/- 128)	53
Fall Creek	10,185 (+/- 3,646)	1,992 (+/- 553)	505 (+/- 408)	661
Deep Creek	9,383 (+/- 2,143)	3,953 (+/- 1,146)	1,078 (+/- 498)	612
Dodge Creek	2,933 (+/- 1,720)	92 (+/- 56)	59 (+/- 105)	332
Twentymile Creek	2,576 (+/- --)	1,235 (+/- --)	82 (+/- --)	37
Caribou Creek	1,840 (+/- 986)	419 (+/- 83)	133 (+/- 90)	4
Snow Creek	1,496 (+/- 325)	119 (+/- 93)	40 (+/- 57)	23
Total Deep Cr. Drainage	63,743 **(+/- 6,310)**	**12,909 (+/- 1,359)**	**3,095 (+/- 678)**	**1,759**
Boulder Creek	**1,050** (+/- **579)**	**347** (+/- **233)**	103 (+/- **97)**	**0**
Myrtle Creek	117 (+/- 93)	110 (+/- **56)**	**62** (+/- **56)**	391

Table 2. Estimated density (fish/l00 m²) of juvenile rainbow trout, by age class (+/- 95% confidence interval), in Kootenai River tributaries from July through September, 1996.

Stream	Total	Aae Class			
		Age 0	Age 1+	Age 2+	Area (m^2)
Trail Creek	108.5	93.5 (+/- 12.5)	11.8 (+/- 1.2)	3.2 (+/- 0.3)	26,431
Ruby Creek	85.4	69.9 (+/- 17.5)	13.1 (+/- 2.1)	2.4 (+/- 0.8)	15,172
Dodge Creek	57.7	54.9 (+/- 32.2)	1.7 (+/- 1.1)	1.1 (+/- 2.0)	5,342
Fall Creek	42.4	34.0 (+/- 12.2)	6.7 (+/- 1.8)	1.7 (+/- 1.4)	29,938
Caribou Creek	26.4	20.3 (+/- 10.9)	4.6 (+/- 0.9)	1.5 (+/- 1.0)	9,031
Snow Creek	21.5	19.5 (+/- 4.2)	1.5 (+/- 1.2)	0.5 (+/- 0.7)	7,960
Twentymile (Browns) Creek[a]	21.0	14.0 (+/- -----)	7.0 (+/- ----)	0.00 (+/- ----)	18,301
Deep Creek	7.8	5.1 (+/- 1.2)	2.1 (+/- 0.6)	0.6 (+/- 0.3)	185,266
Boulder Creek	6.0	4.2 (+/- 8.0)	1.4 (+/- 3.7)	0.4 (+/- 0.9)	25,283
Myrtle Creek[b]	4.5	1.8 (+/- 1.4)	1.7 (+/- 0.9)	1.0 (+/- 0.9)	94,383

[a] Because of low sample size, confidence Intervals were not calculated for Twentymile Creek.
[b] Approximately 93% of the total area in Myrtle Creek is channelized, unsuitable trout habitat and was not included in density estimates.

Table 3. Rainbow trout density estimates (fish/l00 m^2) in surveyed streams by basic habitat type, July through September, 1996.

	Age 0				Age 1				Age 2			
Stream	Pool	Riffle	Glide	PW	Pool	Riffle	Glide	PW	Pool	Riffle	Glide	PW
Trail Cr.	139.4	81.0	118.2	75.8	35.4	5.4	17.7	9.6	16.3	0.8	2.6	0.8
Ruby Cr.	86.8	68.2	82.4	51.8	17.9	11.3	12.5	15.4	9.3	0.5	4.8	0.9
Fall Cr.	76.6	37.2	28.2	------	13.9	4.3	6.4	------	1.6	0.9	1.9	------
Dodge Cr.	51.0	62.7	52.9	------	5.1	0.0	1.8	------	0.7	0.0	1.5	------
Snow Cr.	30.7	7.4	32.1	7.4	1.7	0.4	5.4	0.4	0.8	0.4	0.0	0.4
Caribou Cr.	20.1	15.2	69.2	15.2	9.2	4.0	8.3	4.0	5.5	1.1	3.0	1.1
Browns Cr.	0.006	------	0.250	------	0.144	------	0.126	------	0.025	------	0.010	------
Deep Cr. R. 1	0.2	0.4	0.8	------	0.1	0.6	0.2	------	0.0	0.0	0.0	------
Deep Cr. R. 2	5.6	16.8	12.1	------	6.0	4.6	3.1	------	2.3	0.4	0.6	------
Deep Cr. R. 3	------	------	0.4	------	------	------	1.7	------	------	------	0.9	------
Boulder Cr.	7.9	3.5	7.9	3.5	2.9	1.1	2.9	1.1	0.9	0.3	0.9	0.3
Myrtle Cr.	1.0	2.1	1.0	2.1	4.1	0.8	4.1	0.8	3.6	0.0	3.6	0.0

Deep Creek Weir

Operation of the weir and traps from April through May was compromised by the unusually high flows in 1996. Twice, the weir was destroyed by high water and accompanying debris load and had to be removed until flows receded. During these events, we continued to use the inclined plane outmigrant trap, but we did not have the benefit of a complete weir to direct fish and water flow. Extremely high flows in Deep Creek from April 23 to 30 and May 13 to 29 required that we pull the inclined plane trap as well as the weir, and no data are available for these periods. From June 6 through October 22, we were able to keep the weir completely operational. Trap efficiency estimates were hindered by the continual need to modify our trapping technique, combined with the small number of fish collected and marked during some periods. We estimated efficiency for each trap "configuration" (fishing in conjunction with the weir, with only a portion of the weir, etc.), but had low efficiency regardless of the technique (Table 4).

Based on the number of downstream migrants collected in the inclined plane trap, mid-May through mid-June was the peak period for outmigration (Figure 4). Few or no juvenile rainbow trout were captured during the majority of days from July through September, although there were periods of four to five days each month marked by much higher catches (20-45 fish/day). For example, during a five day period in September, we collected 54 rainbow trout in the downstream trap, which was 87% of our catch for that month.

We used the efficiency estimates and daily catches to approximate daily total outmigration (Figure 5); however, it should be noted that our estimates of daily total outmigration are limited by the variable trap configurations and our inconsistent trap efficiency values. The total daily outmigrant estimates, while of limited quantitative value, are useful in identifying periods of outmigration and possible associated factors. Ninety percent of the rainbow trout collected in the trap were collected during the morning check, indicating that most outmigration occurred at night. The apparent peak in juvenile rainbow trout outmigration was in mid-June, coinciding with the decreasing discharges. Outmigration appeared to be related to discharge in that the peak period for outmigration occurred as discharge dropped from its high of over 1,000 cfs to around 300 cfs. Discharge seemed to have a more pronounced effect following the initial outmigration period in May and June, when Deep Creek reached summer low flows. Small increases in flow, associated with summer storms, were associated with higher daily catches (Figure 4). These same periods of high catches from late July through September were associated with brief drops in temperature of 5-8°C.

Rainbow trout collected in the inclined plane trap ranged from recently emerged fry, about 25 mm TL, to a 520 mm TL post-spawn adult. We plotted separate length frequency histograms of juveniles collected for spring (April-May), early summer (June-July), and late summer (August-September) to depict growth throughout the season (Figure 6). The length of juvenile trout varied widely, but scale analysis indicated fairly distinct breaks between age classes. The majority of rainbow trout collected in the trap were either age 1 (1995 year class) or age 2. We were unable to calculate separate efficiency estimates for different age classes of rainbow trout. Assuming equal capture efficiencies for each age class, the catch of rainbow trout was 13% age 0, 37% age 1, 36% age 2, and 13% age 3+.

Table 4. Trap efficiency estimates based on mark and recapture of juvenile trout during various periods of time and with varying trap/weir configurations.

Trap Configuration	Dates Fished	Total Days	Number Captured	Number Marked	Number Recaptured	Estimated Efficiency (%)	Estimated Total Outmigrants
Partial	4/10-4/22, 4/29-5/7, 5/29-616	31	38	37	0	0	Unknown
Complete	4/3-4/9, 5/8-5/12, 6/7-7/8	43	665	399	11	3.1	21,452
Complete with Plastic Netting	7/9-10/22	106	336	55	6	9.2	3,652
No Trap	4/23-4/28, 5/1 3-5/28	22	0	0	0	0	Unknown
Totals			1,039	491	17		Unknown

[a] Partial = 2-3 weir panels funneling into trap
Complete = Weir panels across entire stream funneling into trap
Complete with plastic netting = Weir panels across entire stream with plastic netting (1/4" holes) covering all panels
No Trap = Trap not in stream due to extremely high water

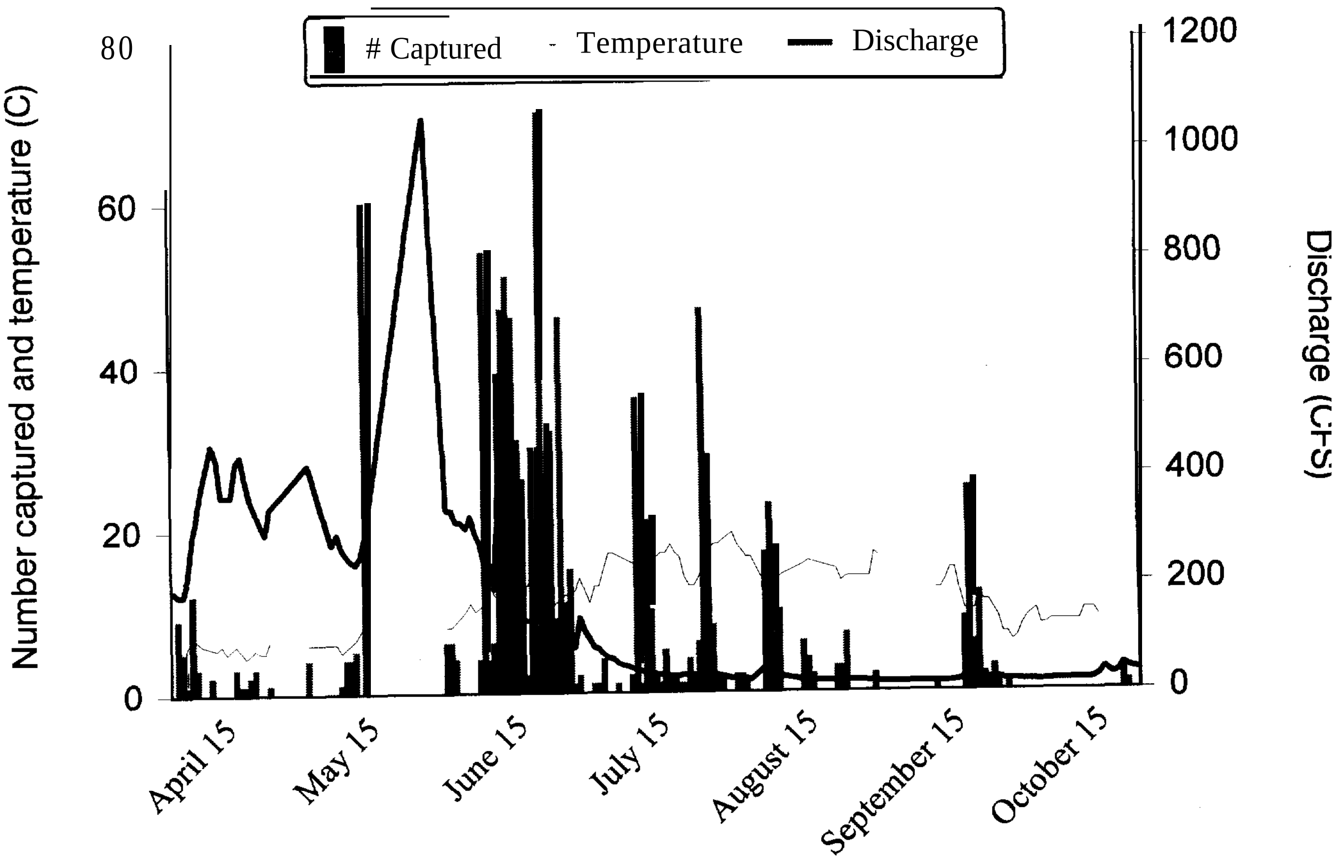

Figure 4. Daily catch of juvenile rainbow trout in the downstream (outmigrant) trap in Deep Creek from April through October, 1996.

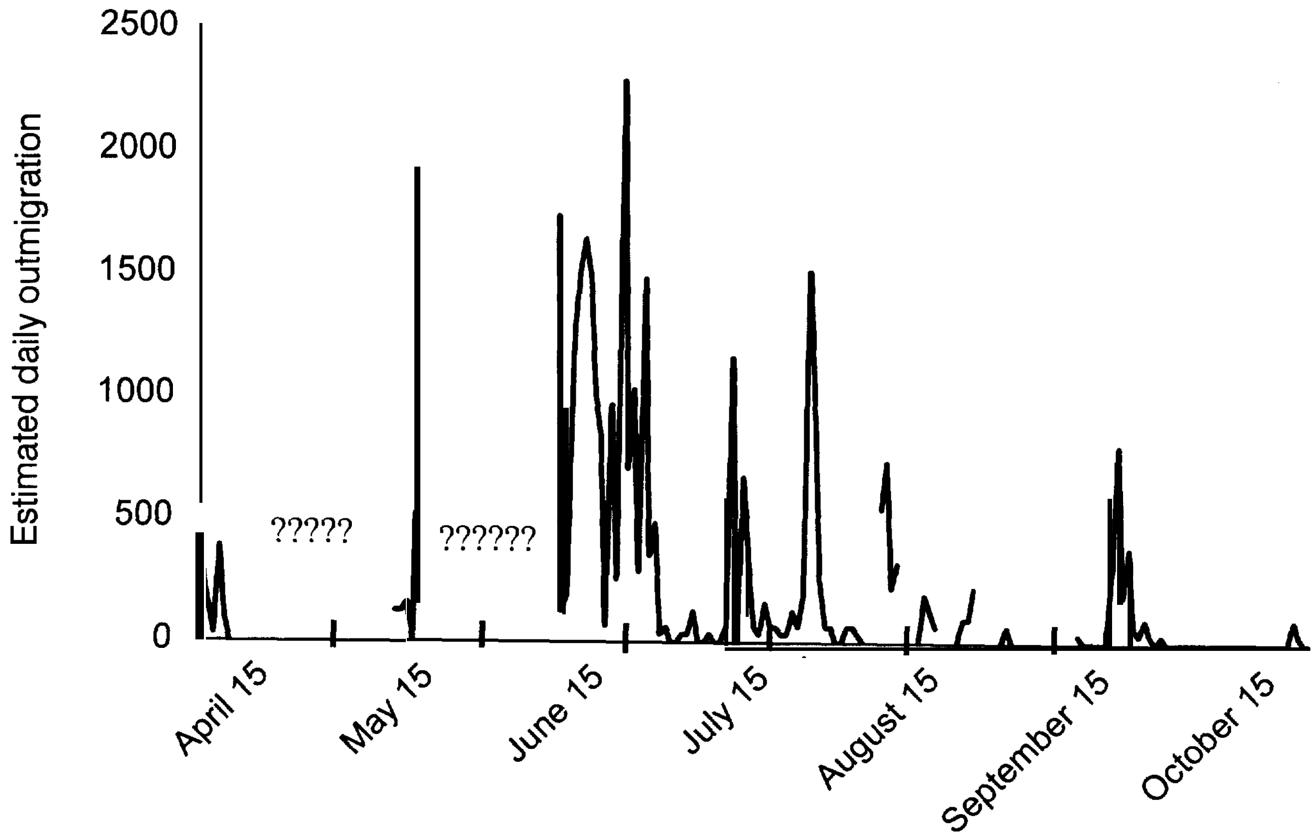

Figure 5. Estimates of total daily outmigration derived from daily catches and corrected with estimated trap efficiency during the period of capture.

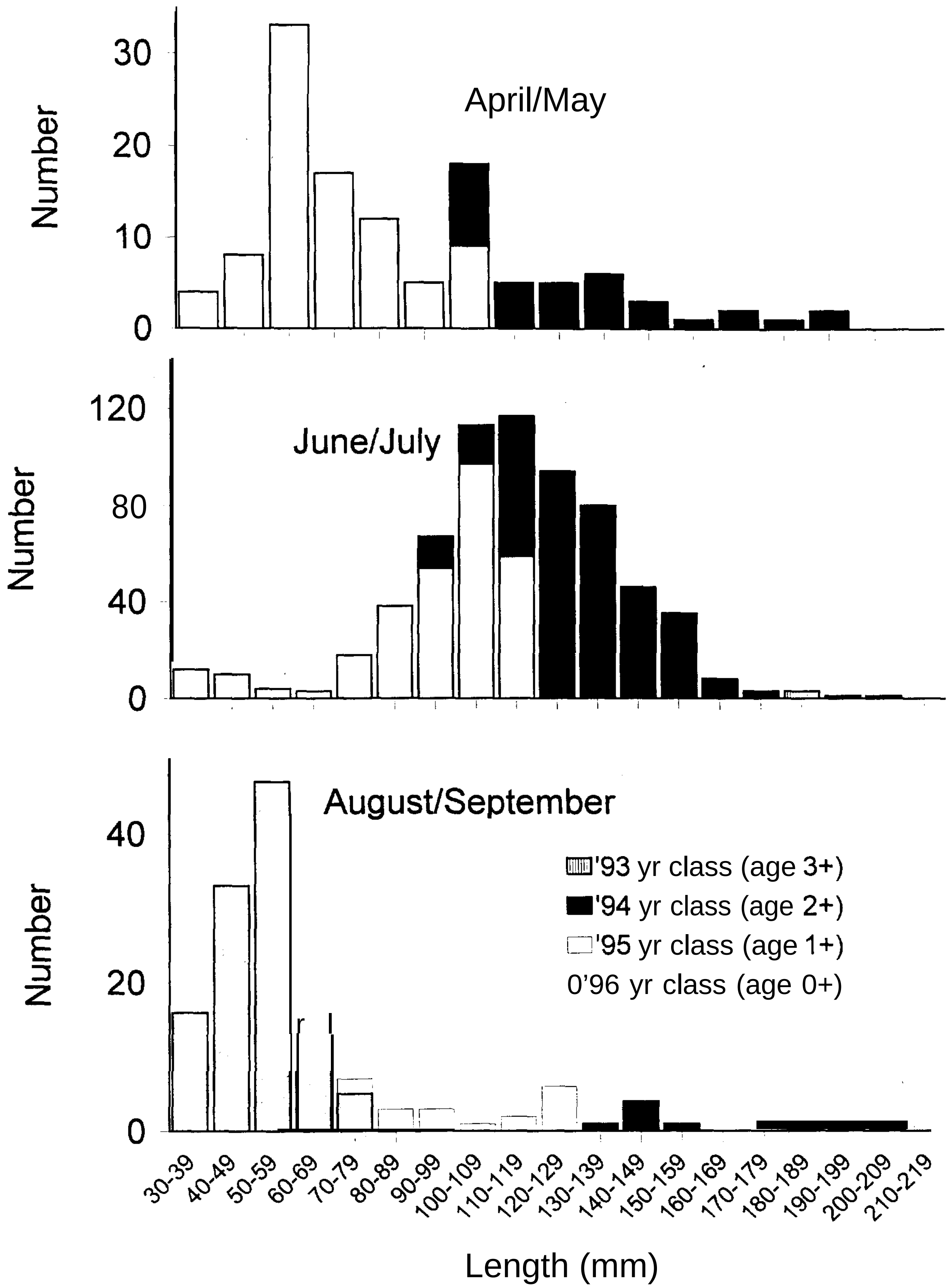

Figure 6. Length frequency histogram and age of juvenile rainbow trout collected in the Deep Creek trap during April/May, June/July, and August/September, 1996.

Thirty-four adult rainbow trout (defined as all trout >200 mm TL) were collected at the weir. Of these, 29 were collected in the downstream (inclined plane) trap and 5 were collected in the upstream trap, Most of the trout collected at the weir had spawned and were apparently migrating out of the Deep Creek drainage. The upstream trap box was inoperational during much of the high flow period, and the majority of the spawners likely passed the weir site during these times. We collected no adult rainbow trout at the weir after June 25. Length of rainbow trout ranged from 202 mm to 520 mm (Figure 7).

A wide range of species in addition to rainbow trout were also collected in the Deep Creek trap. These included juvenile and adult kokanee, brook trout, mountain whitefish, longnose suckers Catostomus *catostomus*, peamouth *Mylocheilus caurinus*, squawfish *Ptychocheilus oregonensis*, redside shiners *Richardsonius balteatus*, longnose dace *Rhinichthys cataractae*, brown bullheads *Ameiurus nebulosus*, yellow perch *Perca flavescens*, largemouth bass *Micropterus salmoides*, sculpins *Cottus sp,* and pumpkinseeds *Lepomis gibbosus* (Table 5).

Mainstem Habitat Use

Redd Surveys

We were unable to identify any evidence of rainbow trout spawning activity in the main Kootenai River. No redds or spawning pairs were observed. On April 5, discharge was only 10,200 cfs and water transparency was relatively high. We were able to identify several areas that might provide spawning habitat for rainbow trout, but in general, we found very little substrate smaller than cobble. Thus, available spawning habitat appears limited to only the largest rainbow trout. The high water in the Kootenai River beginning in mid-April (41,700 cfs on April 13) greatly increased the depth of areas that initially appeared to be marginally suitable for spawning. The increased depth and resultant decline in transparency limited our ability to see the substrate. Over a five-week period (April 5-May 9), visibility was sufficient only during two weeks, those beginning April 5 and May 8, to have made identification of redds likely.

Adult Trout Tagging

A total of 45 rainbow trout were reward tagged between April 5 and June 25. Twenty-six of these were collected at the weir and the remaining were collected with conventional fishing equipment. To date, we have had only one tag returned. This fish was harvested in the meandering reach of the main Kootenai River near the mouth of Flemming Creek (rkm). We also observed a tagged rainbow trout during snorkel counts in upper Trail Creek, nearly one month after it had been tagged at a nearby location. This was one of the very few adult rainbow trout that we saw in Trail Creek, indicating it was one of only a few resident fish, or that it was a fluvial fish that had not yet returned to the Kootenai River.

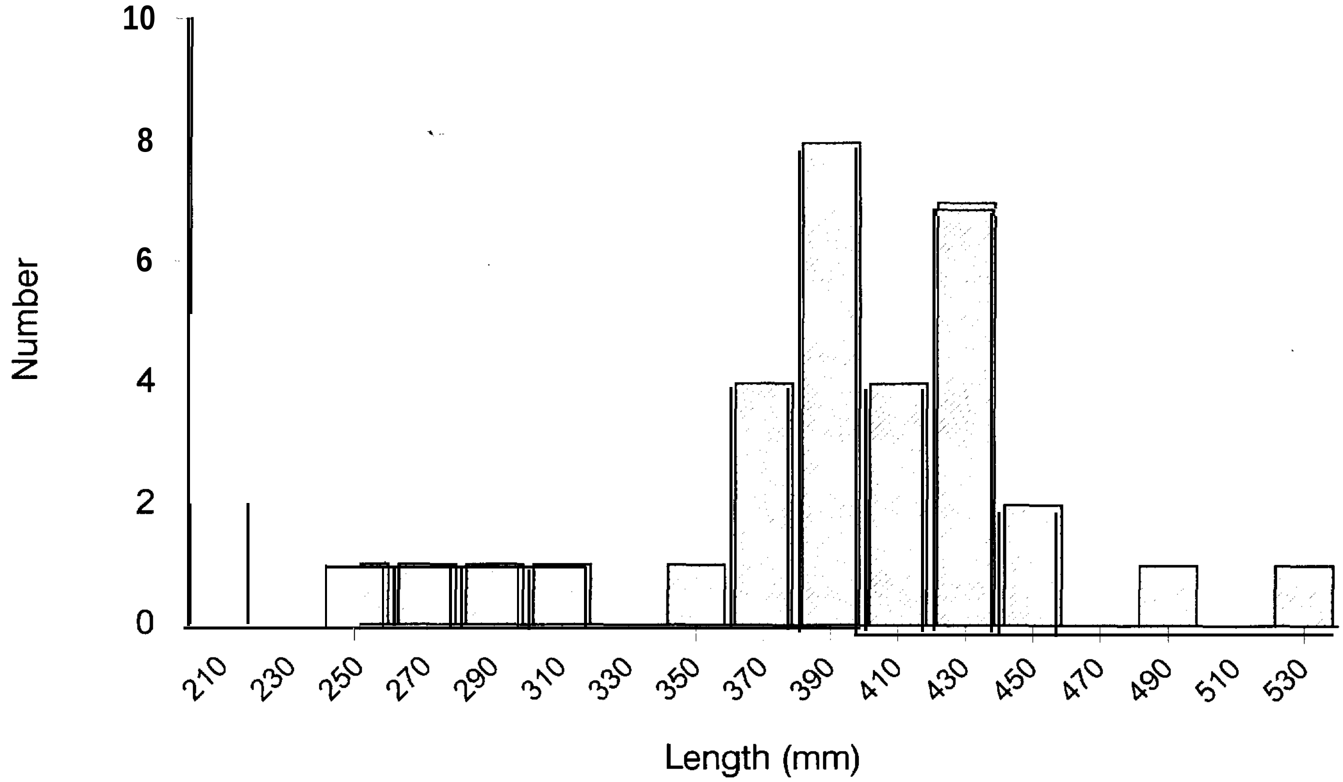

Figure 7. Length frequency histogram of rainbow trout greater than 200 mm collected in the Deep Creek trap in 1996.

Table 5. Total number of other fish species collected in the downstream trap in Deep Creek in bimonthly intervals from April through October, 1996.

	Longnose dace	Mountain whitefish	Suckers (longnose & largescale)	Peamouth	Yellow perch	Redside shiner	Northern squawfish	pumpkin-seed	Largemouth bass	Kokanee	Brook trout	Sculpin	Brown bullhead
April I-I 5	12	3									1		
16-30	1						1	1			1		
May I-15	7	2											
16-31													
June 1-15	21	07	30						2				
16-30	29	99	81			4							
July **1-15**	374	221	29		9	18					1	1	
16-31	200	57	25	79	7	25	6	1	3	11			1
August I-15	54	18	4	99	**8**	42	39	9	11				
16-31	39	2	4	2	1	13	2	7					
September I-I 5	23	6	1	5	4	2	4	a		**1**			
16-30	116	**78**	35	9	67	7	3	2			1	2	1
October I-I 9	167	2	58	6	46	12	19	2			2	1	1
TOTAL	1,043	575	267	200	142	123	74	30	16	12	6	4	3

Of the eight radio-tagged fish, one was harvested by an angler at the same site only five days after it was tagged. We successfully followed the remaining trout as they migrated out of the Deep Creek drainage and into the Kootenai River. All fish migrated down to the Kootenai River within 11 days of when they were tagged. Once in the river, the limited range of radio reception hindered effective tracking. Aside from a presumed mortality, which has remained at the mouth of Deep Creek since June, only one trout was continually located. This fish, which was tagged May 23 in upper Trail Creek, moved downstream to the mouth of Myrtle Creek (rkm 234), where it was located on June **18.** On June 24, it had moved down to Shorty's Island (rkm 230), but by July 1, it was back at Myrtle Creek, where it was again relocated on October 21. The other five implanted rainbow trout have not been located.

DISCUSSION

Juvenile rainbow trout densities in the Deep Creek drainage could be considered average to high in many of the streams surveyed despite the embedded substrates and poor condition of the riparian area. Density of juvenile rainbow trout (age 0 to age 2+) exceeded 60/100 m^2 in three of the streams, with the highest in Trail Creek at 109/1 00 m^2. As a basis for comparison, Hoelscher and Bjornn (1987) snorkeled streams in six tributaries to Lake Pend Oreille to estimate juvenile rainbow trout production and found mean reach densities ranging from 1 1/100 m^2 to 56/1 00 m^2. Thurow (1982) estimated juvenile cutthroat densities in some of the most productive (in terms of juvenile trout production) upper reaches of tributaries to the Blackfoot River at 75/1 00 m^2 to 180/1 00 m^2. Corsi and Elle (1989) surveyed a grazed and ungrazed reach of Duck Creek (tributary to Henry's Lake) and found juvenile cutthroat trout densities of 32/100 m^2 and 17/1 00 m^2, respectively. In the Coeur d'Alene drainage, Lider and Techau (1994) reported juvenile (age 0 only) cutthroat trout densities in 17 streams were generally less than 10 fish/l 00 m^2, but ranged as high 300 fish/l 00 m^2 from 1985 to 1993, and Lukens at al. (1976) estimated juvenile trout densities from 59/100 m^2 to 500/100 m^2 in Wolf Lodge Creek (an important cutthroat trout spawning and rearing tributary to Lake Coeur d'Alene).

Despite areas of reasonably good production, the total number of juveniles produced in the Deep Creek drainage is limited by the amount and quality of available habitat. Sixty-two percent of the total available habitat (by area) in the Deep Creek drainage is in Deep Creek itself. Historic production in Deep Creek is unknown, but the low trout densities in Deep Creek, particularly of age 0 rainbow trout, are likely due in part to the degraded streambanks, embedded substrates and high water temperatures (we recorded afternoon temperatures of 26°C in July). Without an estimate of historic levels of production, we are unable to gauge the current production status of the Deep Creek drainage. Again for comparison, Thurow (1982) reported the total length of tributaries utilized by fluvial cutthroat trout in the Blackfoot River system for spawning and rearing was around 43 km, comparable to the 47 km in the Deep Creek drainage. In 1979 and 1980, those authors estimated the total number of juvenile cutthroat trout in the 43 km system to be 200,000 and 140,000, respectively. In the Deep Creek system, we estimated a total of only 86,000 juvenile rainbow trout.

Unfortunately, the weir was of limited use in confirming the production estimates of the Deep Creek drainage. Trap efficiency was difficult to estimate because of the low number of recaptured fish and high flow periods when the trap was inoperable. We even had a low number of recaptures with the complete weir covered with 6 mm plastic netting, and were confident outmigrating trout would be directed into the trap. The low recapture rates may have been the result of undetected holes in the weir or of high mortality associated with trapping and handling the fish. Another possibility is that marked fish residualized above the weir rather than continuing their outmigrating behavior, and that rainbow trout outmigrants in this system may not have as strong an impulse to outmigrate as anadromous salmonids. The peak outmigration seemed to occur during the decreasing flows in June and July, but the inability to operate the trap during the high flows negates an estimate of total outmigration. The estimated total outmigration during the periods when we were able to estimate trap efficiency was 25,100. This doesn't include the possibly large number of outmigrants during the high flow periods when the trap was not in place, nor the periods when trap efficiency was immeasurable. Those periods total 53 days and likely would have contributed greatly to the estimated total outmigration. We used estimated daily outmigration during the periods when the trap was operable from April through June (498 fish/day) to fill in the periods when no estimates were possible. This resulted in an estimated 26,400 additional outmigrants for a total estimated outmigration from April through October of 51,500. This estimate assumes the extremely high discharges that precluded trapping did not influence outmigration. Because of the assumptions involved and the difficulty estimating efficiency, the estimate should be used only in accordance with the total juvenile estimates from the stream surveys. Based on the evidence that most juvenile rainbow trout outmigrate at age 1+ and age 2+, the estimate seems fairly consistent with what we might expect from the drainage (Table 1).

Assuming juvenile production estimates based on stream surveys and outmigrant trapping are reasonably accurate, the Deep Creek drainage and other tributaries in Idaho are probably insufficient to fully seed the Kootenai River. We do not yet have an estimate of the amount of "suitable" rainbow trout habitat in the Kootenai River based on microhabitat variables and discharges. IFIM work conducted by MDFWP will make such estimates possible in 1997. However, we do know that of the approximately 105 km reach of the Kootenai River, Idaho, about 32 km appear to be good rainbow trout habitat (canyon reach and braided reach). The low gradient, meandering reach may be suitable rainbow trout habitat, but less so than the upper reaches. Population estimates in the Montana reach of the Kootenai River indicate approximately 312 adult rainbow trout/rkm (Larry Garrow, MDFWP, personal communication), which are low in comparison to more productive systems, such as the section of Spokane River from Post Falls Dam to the Idaho-Washington state line (approximately 2,000/rkm) (Bennett and Underwood 1988) and extremely productive rivers such as the Green River, Wyoming (6,000 - 12,000/rkm) (Johnson et al. 1987). Assuming the canyon and braided reach could support similar densities as the upper Kootenai River, we would expect over 9,000 adult rainbow trout in those reaches alone. If the meandering reach could support even half of that (150/rkm), we could expect an additional 22,000 adults. If recruitment is dependent on tributaries in Idaho, the estimated number of juveniles produced in the tributaries is probably not enough to support even relatively low densities in the Kootenai River, once mortality is accounted for.

The extent of the range used by trout spawning in Idaho tributaries clearly influences the sufficiency of seeding. For the purpose of this study, we have assumed that rainbow trout utilizing the Idaho section of the Kootenai River spawn in Idaho tributaries. Some juvenile trout likely immigrate from Montana. However, researchers from MDFWP believe the trout population in the Kootenai River below Kootenai Falls is underseeded, and doubt that a large number of juvenile rainbow trout would emigrate to Idaho given the abundant available habitat (Steve

Dalbey, MDFWP, personal communication). The downstream extent of the range is not yet established. Long-time area residents report large (IO-15 Ibs) rainbow trout spawning in Deep Creek and other streams in Idaho, and even in Callahan Creek in Montana. These fish were widely believed by anglers to be adfluvial fish, based on their large size. Although possible, researchers in British Columbia report "the large rainbow trout caught in the [Kootenai Lake] fishery are thought to have been derived from two stocks of trout, both spawning in restricted portions of the northern inlet to Kootenay Lake" (Irvine 1978). These trout are considered genetically distinct from other rainbow trout stocks utilizing Kootenay Lake (Cartwright 1961). Furthermore, Chapman (1986) reports that, based on isozyme analysis, rainbow trout below Kootenai Falls resembled Kootenay Lake rainbow trout more than those sampled above the falls, but still differed significantly in genetic makeup. These reports seem to indicate that, while some exchange may occur between Kootenay Lake and the Kootenai River below Kootenai Falls, adult fish utilizing the river and tributaries in Idaho are probably not adfluvial.

Our lack of knowledge concerning rainbow trout habitat use in the mainstem Kootenai River underscores the need to continue tagging and movement studies. Thus far, telemetry and reward tag returns have only identified the locations of two fish, both of which migrated downriver from the mouth of Deep Creek to the meandering section of river. We believe reward tags will eventually provide useful information on adult trout movements when enough fish are tagged that a sufficient number are harvested and reported. Unfortunately, capture of a large number of spawners at the weir is dependent on the absence of high flows such as those in 1996, and adult trout tagging may be limited to those fish caught with conventional fishing equipment in the tributaries. Radio telemetry will be particularly useful if the quantity of trout we can collect is limited. Use of a higher frequency transmitter and/or a Yagi antennae will likely provide better results than in 1996. In addition, future electrofishing population estimates should provide information on mortality rates and the relative importance of the respective mainstem reaches to various age classes of trout.

RECOMMENDATIONS

1. Conduct additional estimates of juvenile rainbow trout in tributary streams to supplement and replicate efforts in 1996.

2. Use higher frequency radio-tags to track spawning rainbow trout and identify mainstem habitat use.

3. Estimate population by age class of rainbow trout in selected reaches of the Kootenai River.

4. Continue mainstem Kootenai River spawning surveys in 1997 if flows permit.

5. Trap upstream and downstream migrating rainbow trout in Deep Creek to implant reward tags in adults and estimate total number of outmigrants in 1997.

6. Using IFIM model developed by MDFWP, estimate the number of juvenile rainbow trout necessary to fully seed the available rainbow trout habitat in the Idaho section of the Kootenai River.

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LITERATURE CITED

Bennett, D.H., and T.J. Underwood. 1988. Population dynamics and factors affecting rainbow trout in the Spokane River, Idaho. Department of Fish and Wildlife Resources, College of Forestry, Wildlife, and Range Sciences. Job Completion Report Number 3. University of Idaho, Moscow.

Bowler, B. 1975. Factors influencing genetic control in lakeward migrations of cutthroat trout fry. Transactions of the American Fisheries Society 104:474-482.

Brannon, E.L. 1967. Genetic control of migrating behavior of newly emerged sockeye salmon fry. International Pacific Salmon Fisheries Commission. Progress Report Number 16.

Chapman, D.W., and B. May. 1986. Downstream movement of rainbow trout past Kootenai Falls, Montana. North American Journal of Fishery Management 6:47-51.

Cartwright, J.W. 1961. Investigation of the rainbow trout of Kootenay Lake, British Columbia. British Columbia Fish and Game Branch, Management Publication No. 7.

Corsi, C., and S. Elle. 1989. Regional Fisheries Investigations. Federal aid in fish restoration. Idaho Department of Fish and Game. Job Performance Report, Project F-71-R-12, Boise.

Hankin, H.G., and G.H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fishery and Aquatic Science 45:834-844.

Hoelscher, B., and T.C. Bjornn. 1987. Habitat, densities of trout and char, and potential production in Pend Oreille Lake tributaries. Federal aid in Fish Restoration. Idaho Department of Fish and Game. Job Completion Report, Project F-71-R-10, Boise.

Idaho Department of Fish and Game. 1996. Fisheries Management Plan, 1996-2000, Boise.

Irvine, J.R. 1978. The Gerrard rainbow trout of Kootenay Lake, British Columbia--a discussion of their life history with management, research and enhancement recommendations. British Columbia Fish and Wildlife Branch. Fisheries Management Report, No. 72.

Johnson, J.E., R.K. Kramer, E. Larson, and B.L. Bonebrake. 1987. Flaming Gorge tailwater fisheries investigations: trout growth, harvest, survival, and microhabitat selection in the Green River, Utah, 1978-l 982. Contract number 14-16-006-78-405 and 8-07-40-X0743, Bureau of Reclamation and Federal Aid to Fisheries Restoration Project F-43-R. Utah Department of Natural Resources, Division of Wildlife Resources, Salt Lake City.

Lider, E.L., and H.B. Techau. 1994. Taft-Bell sediment and fishery monitoring project. U.S. Forest Service. Draft Final Report, No. DE-A179-85 BP 23203. Coeur d'Alene, Idaho.

Lukens, J., T.C. Bjornn, and R. Van Gundy. 1976. Wolf Lodge creek cutthroat trout studies. University of Idaho. Forest, Wildlife and Range Experiment Station, No. 45, Moscow.

Paragamian, V.L. 1994. Kootenai River fisheries inventory: stock status of burbot and rainbow trout and fisheries inventory. Idaho Department of Fish and Game, Annual Report to Bonneville Power Administration, Project 88-65, Boise.

Paragamian, V.L. 1995. Kootenai River fisheries inventory: stock status of burbot and rainbow trout and fisheries inventory. Idaho Department of Fish and Game, Annual Report to Bonneville Power Administration, Project 88-65, Boise.

Partridge, F. 1983. Kootenai River fisheries investigations. Idaho Department of Fish and Game. Job Completion Report, Project F-73-R-5, Boise.

Raleigh, R.F. 1971. Innate control of migrations of salmon and trout fry from natal gravel to rearing areas. Ecology 52:291-297.

Raleigh, R.F., and D.W. Chapman. 1971. Genetic control in lakeward migrations of cutthroat trout fry. Transactions of the American Fisheries Society 100:33-40.

Ross, M.J., and CF. Kleiner. 1982. Shielded-needle technique for surgically implanting radio-frequency transmitters in fish. Progressive Fish Culturist 44:41-43.

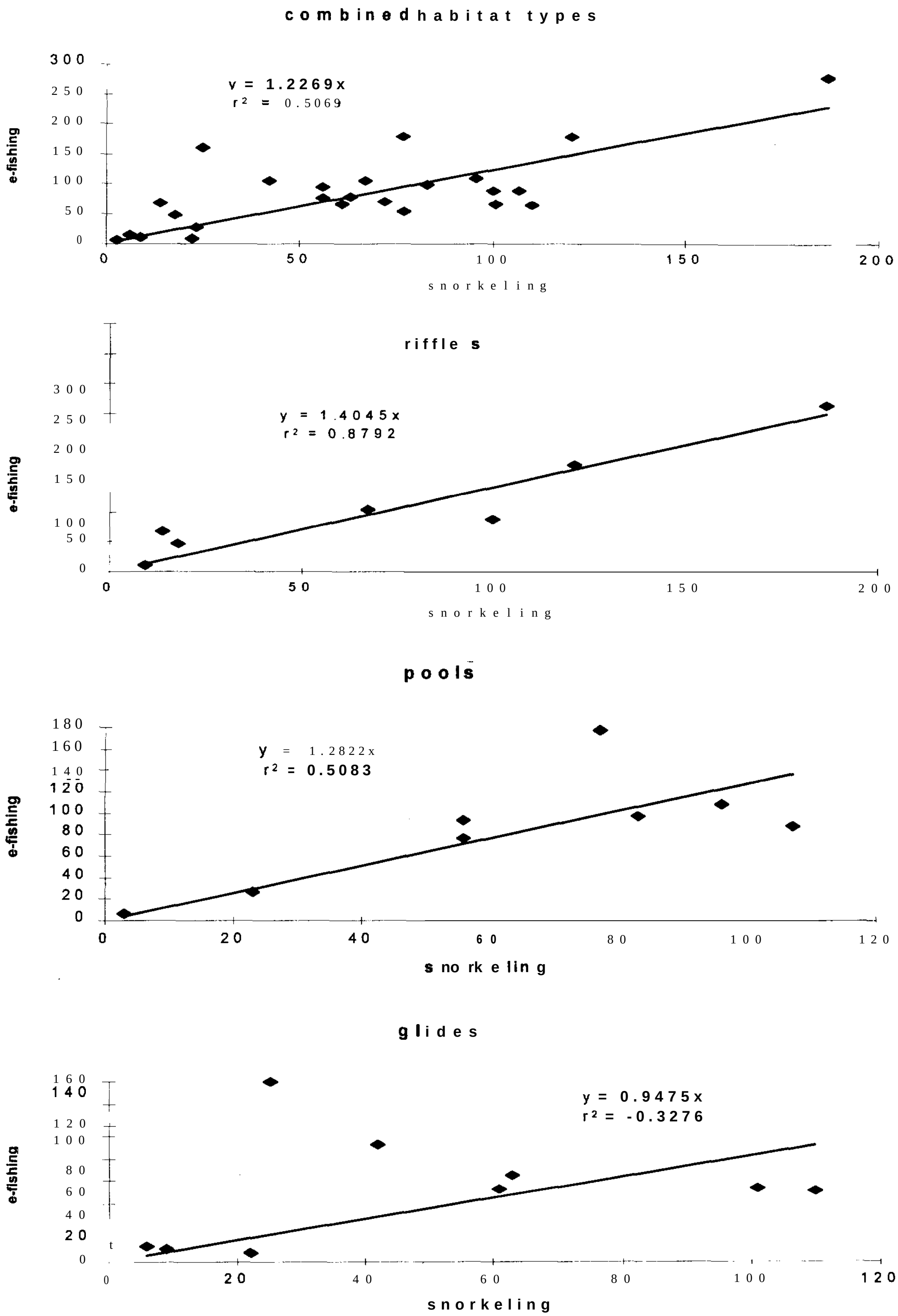
Scheaffer, R.L., W. Mendenhall, and L. Ott. 1990. Elementary Survey Sampling, 4th edition. PWS-Kent, Boston, Massachusetts.

Skaar, D. 1993. Effects of 1993 sturgeon flows on rainbow trout spawning in the Kootenai River and fish entrainment through Libby Dam. Montana Department of Fish, Wildlife, and Parks, Report to Bonneville Power Administration.

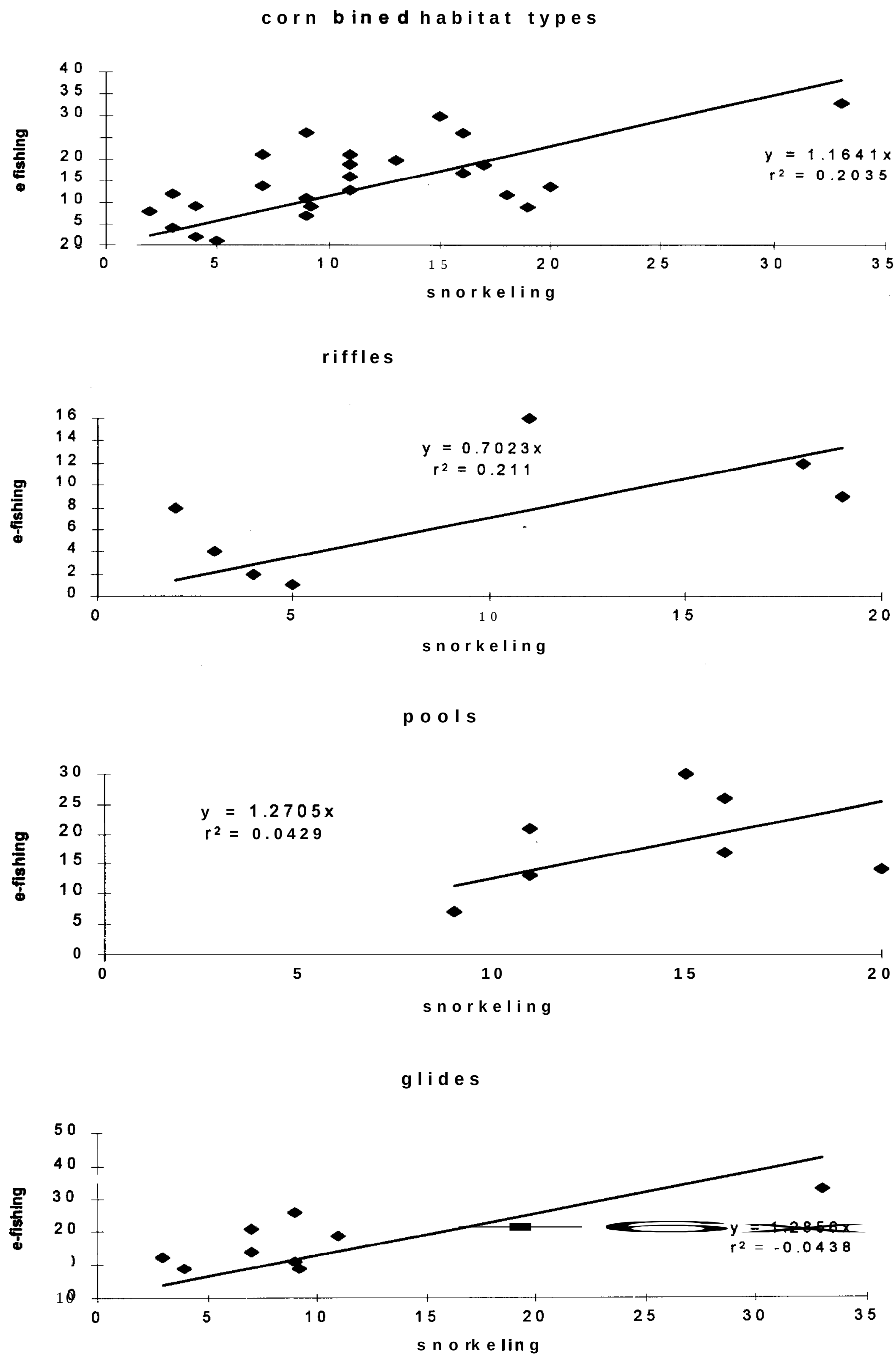
Thurow, R. 1982. Blackfoot River Fisheries Investigations. Federal Aid to Fish and Wildlife Restoration. Job Completion Report. Project F-73-R-3. Idaho Department of Fish and Game, Boise.

Winter, J.D. 1983. Underwater biotelemetry. Pages 371-375 in L.A. Nielson and D.L. Johnson, editors. Fisheries Techniques. American Fisheries Society, Bethesda, Maryland.

A P P E N D I C E S



Appendix A. Correction factors (y) based on the relationship between the number of age 0 rainbow trout estimated by snorkeling and by electrofishing in a habitat unit.



Appendix B. Correction factors (y) based on the relationship between the number of age 1+ rainbow trout estimated by snorkeling and by electrofishing in a habitat unit.

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